CHAPTER

12

Food: natural and environmental considerations

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12.1 Sustainable natural resource limitations and resource wastage

Environmentalism and sustainability are two buzzwords that have come to represent an awakening of the people's collective conscience over the last two decades or so. Pedantically, the two words have slightly different meanings, yet there is sufficient overlap that they are commonly used interchangeably. Environmentalism dwells on the larger picture, whereby the earth's physical surroundings as well as the flora and forna are the focal points. All in all, the environmentalist movement takes a balanced overarching view to earth's continuing conservation and maintenance the big picture, so to speak. On the other hand, sustainability takes a slightly different view, looking at the environment from usage and finite resource perspective. In this way, sustainability is a term promoting a sensible way of utilizing natural resources that neither overstresses their existing or future potential nor degrades resources to the point of collapse.

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Over the past 50 years or so, there has been an increasing awareness of the finite nature of the Earth's natural resources. More than this, environmentalism, although covering the full gamut of humanity's needs, is increasingly being used in the same breath as food and food production (Gibson, 2016). That aside, an increasing reliance on the natural resources from an equally increasing population places greater stress on resources, which in turn jeopardizes the sustainability of such resources. As a consequence, there has been growth. Consequently, over the last few decades there has been continuing growth not only in environmental organizations, programs, and charities but also a concomitant fundamental shift in the way we, as a race, view ourselves, particularly when it comes to our relationship with Mother Nature. This is especially prevalent in the way that some people have chosen to coexist with Mother Nature. They no longer see themselves as the sole end users of the Earth's products; instead, many see themselves as custodians of a finite resource base: "a mutually beneficial symbiotic relationship" (Gibson, 2016). What was once a marginal movement had now become mainstream; environmentalism and sustainability were here to stay. This will have ramifications that continues to touch upon all aspects of our lives not only today but for future generations to come (Steck, 2014).

The second half of the 20th century witnessed increasing global population numbers, which point that food production had almost doubled. Yet such an achievement was without much consideration to the environment or the sustainability of the Earth's natural supplies production. With overreliance on chemical inputs; excessive use of fossil fuels; and from inappropriate water management, among others, agricultural production left rather a large environmental footprint on an already stressed ecosystem (Khan and Hanjra, 2009). It is not as if we did not see it coming, as such issues were tentatively pointed out in the 1920s with Rudolph Steiner's organic biodynamics and in the 1960s with Rachel Carson's views on questionable agricultural practices of the day. Yet even in spite of this, it was not until perhaps 1972 with the United Nations Environment Protection conference in Stockholm that such issues were received by a more aware and understanding audience. The message was well received and by the 1980s the notion of the need for an almost ever-expanding food supply and the potential negative consequences for the environment was drastically reshaping the agricultural production industry. More sustainable agricultural practices, conservation programs, and an all-round modified attitude toward sustainability was an easy sell firmly grounded in common sense. Consequently, the environmental movement now enjoys widespread priority in policy decision-making that simultaneously serves to protect the environment and to improve standards of living, as well as food security and numerous other goals (Nathoo and Shoveller, 2003; Ericksen, 2008).

However, nowadays, people have gone further by understanding the implications of doing nothing that there has been considerable backlash against agricultures high-energy, high-intensity industrialization of the food chain leading to a sort of modern renaissance represented by a sweeping array of alternative agricultural systems, whether organic, low input biodynamic, traditional, or indigenous or any other number of environmentally friendly systems (Chappell and LaValle, 2011).

12.2 Sustainable agriculture

In large part thanks to the green revolution, more food is grown today than at any other time in history, yet there is much discussion over whether modern agricultural practices are sustainable. Many reasons are cited for this, ranging from the intensive application of fossil-based technologies (fertilizers, mechanization, transport) to the reduction of biodiversity associated with modern farming techniques, as well as general environmental degradation (land, climate) (GFS, 2011). As a result, the past few decades have witnessed the increased implementation of sustainability theories and technologies. Sustainability has as its ultimate focus the ecosystem. Ecosystems are found both at the micro- and macrolevels; they can be small and revolve around small geographic areas such as local rivers or marshlands or they can be thought of in larger scales as in the Sahara or the Arctic, etc. The main point is while the earth can be thought of as one large ecosystem, there are a myriad of smaller sometimes overlapping ecosystems that make up the whole; just how many there are is a matter of debate.

A well-functioning ecosystem provides us not only with the food and other natural raw materials we so rely on but also it ensures management in areas of land and soil erosion or formation control, nutrient cycling, and carbon sequestration, among others. Ecosystems also regulate the hydrological and biological regimes as well as controlling pests and diseases, pollination, detoxification of wastes, and climate. Within this framework, sustainability looks to preserve these ecosystems in perpetuity.

That being said, sustainability is not a new concept—lack of diversity and the fear that the Earth was becoming "man-heavy" led Mehta in 1929 to quote from the expressive language of the Sanskrit's in cautioning against short-termism:

> … the excessive milking of the agricultural cow so that nothing is left for the nourishment of the calf …
> *Mehta (1929), pg84.*

As a result, today's growing ethos is more about producing food and other goods in a responsible, environmentally friendly manner that looks favorably on the inclusivity of the global allotment. Yet sustainability practices, however laudable, are slowly and sometimes reluctantly adopted. This can be for all sorts of reasons from short sightedness to greed, economic considerations, rights-based issues, political support, and persuasion—in fact any number of reasons. Another hindrance, albeit one that is slowly changing as momentum increases, is that sustainability gains in local ecosystems are usually first and foremost felt at the local level through increased robustness of the system, reduced vulnerability, and better overall resilience, etc. While this translates into better productivity, improved longevity of the system and the many esthetic and recreational impacts people are only now fully coming to understand these local ecosystems are in fact interconnected. With this comes the realization that one cannot improve local land potential at the expense of nutrient runoff for example, which is going to affect the fish farm or the water supply in the next village or town. Nor can we fell swathes of forested land through slash and burn practices without consideration of the wider climate change potential.

While sustainability looks to preserve these ecosystems, it also looks to address years of abuse or neglect. Thus, a mixture of preventative and remedial measures such as reversing

land degradation, climate change mitigation (reduced emissions and enhanced carbon sequestration), the conservation of biodiversity, and the protection of water resources are all employed to address the issues at hand. In terms of agricultural sustainability, this progress manifests itself in many forms from consideration of chosen methods of production to the more sympathetic use of inputs, etc. One consideration over agriculture for which system is chosen over any other is partly determined by the climatic environments. Tropical environs allow for any or all of the above practices while subtropical and arid environments are limited to such things as sunshine and/or rainfall. There are inherent advantages of each method too, monocultures, for instance, although the practice receives a lot of bad press, in and of itself the monoculture is not intrinsically environmentally "unsound," rather the problems of monoculture reflect the poor execution of this farming method. However, monoculture does benefit from reduced competition for nutrients and the cost reduction bonuses of large-scale industrial production. Polycultures, on the other hand, benefit from year-round production and diversity in the ecosystem as well as less leaching of the nutrient soil-base. Therefore, understanding the geophysical and climatic limitations of a particular region ensure the right practice is chosen for the right set of circumstances. In turn this has the potential to maximize productivity and lessen the risk of waste due to inappropriate, wasteful, or unnecessary inputs.

However, in reality, the best or most appropriate farming practice is not always chosen, perhaps also the right system might be in place but is subject to abuse, or simply a resource or practice is overwhelmed through improper or overuse. The following looks at some of the impacts our current global food supply setup is impacting on our natural resources.

12.3 The impact of food consumption on the agroecological resource base

Amidst these concerns and a growing awareness of the ill effects of humankind's relentless drawings of the earth's natural resource base, more so over the last few decades as many people are now tuned into the understanding that continuing on the present course is simply unsustainable (GEO, 2007; Dyer, 2006a,b). By way of example, in the European Union (EU), food production and consumption alone are responsible for 28% of material resource use in the EU, in turn generating the following:

- 20%–30% of total EU environmental impacts
- 17% of all direct greenhouse gas emissions (Europa, 2012)

Thus, out of necessity and more importantly fundamental belief in the ideology of sustainability, many people began to question the status quo that saw the Earth as little more than a bottomless larder. This view was confirmed back in 1992 in a moment of clarity, which was also reaffirmed at the Rio Earth Summit by the Union of Concerned Scientists when they suggested

> Human beings and the natural world are on a collision course … The Earth is finite. Its ability to absorb wastes and destructive effluent is finite. Its ability to provide food and energy is finite. Its ability to provide for growing numbers of people is finite. And we are fast approaching many of the Earth's limits. ***UCS (1992)***.

Some of the key drivers behind these unsustainable consumption patterns include growing population, increasing urbanization, and rising incomes (GEO, 2007). And these drivers are likely to continue; yet, if current trends of resource-intensive consumption patterns continue, it has been reported that humanity will require the equivalent of two Earths to support the projected population by 2030 (UNEP, 2012). This does not take into account other associated challenges of production such as competition from animal feed, industrial usage, or climate change variability. Indeed, on this last point, it is suggested that the effects of climate change alone are expected to reduce yields by up to 25% in some areas (Nellemann, 2009; UNEP, 2012).

Presently, global agriculture production is already an extremely resource-intensive sector. On top of this, pressure on worldwide resources is being further compounded by unrelenting demand from growing populations with ever greater food production needs section (UNEP, 2012). Currently, global food production sector utilizes about one-quarter of all habitable land on earth and uses more than 70% of total freshwater consumption. As a result, the world's food production sector has become the largest single cause of biodiversity loss in the world; it produces over 30% of global greenhouse gas emissions; it is responsible for as much as 80% of total annual deforestation contributing to its roles as the single greatest cause of land use change throughout the world. However, the following gives a small glimpse of the effects our food production sector is having on our planet's land and water resources.

Only one-quarter of the earth's land surface is suitable for cultivation and within these confines' cattle occupy about 25% of this land with feed required to sustain these and other livestock requiring another 25%. Recalling too that livestock is an inefficient use of resources—requiring 7 kg of grain to produce just 1 kg of animal protein. Therefore, it should come as no surprise that approximately 35% of the total global grain harvest is ultimately used in the production of feed, resulting in animal protein. Indeed, in many regions around the world, the majority of new agricultural land brought into play is employed simply for this purpose of supplying the growing market for animal protein, whether directly in the production of animals or for animal feed. This is perhaps no more evident than in the high-profile deforestation patterns as seen in Brazil's national treasure—the Amazon. In 2007, for instance, ranches in the Amazon covered about 8.4 million ha[1], which, according to Nellemann, is suggestive of simple market responses to global demand (Nellemann, 2009). Furthermore, if consumption trends continue as predicted, animal protein consumption is set to increase by a factor of 4 by 2050 placing further pressure on existing land resources (UNEP, 2012).

Available land is only one part of the equation; maintaining adequate food production, whether land or water based, relies on well-functioning ecosystems, which in turn rely on healthy and sustainable practices with the long term in mind. Unfortunately, continued misuse and abuse of the land has led to widespread degradation the full scale of which is only recently coming to light.

By way of example, intensive agricultural practices during the second half of the 20th century directly led to the degradation of 2 billion hectares of arable land (about one-quarter of all arable land). And it does not stop there—it is estimated a further 2–5 million hectares are added to this figure annually (Nellemann, 2009). Overall, this leads to very real losses; according to the International Food Policy Research Institute (IFPRI) such degraded lands

[1]In Brazil in 2007 ranches alone accounted for an estimated 70% of deforestation in that year.

lead to nonoptimized yields amounting to the loss of about 20 million tons of grain or 1% of global annual grain production each year (IFPRI, 2011). In terms of freshwater resources, agriculture as mentioned utilizes about 70% of global annual supply. Continued agricultural pollution from intensification is threatening the current sustainability of the system resulting in unnecessary acidification and dead zones within our river and aquifer ecosystems, etc. Apart from implications of land-based production, this also comes at a time when fish consumption is at an all-time high with fish contributing to 15% of animal protein intake for over 3 billion people (or equivalent to about 17 kg per global capita) (UNEP, 2012). Yet amid these figures, the industry is in perilous condition as approximately 75% of the world's major marine fish stocks are either depleted or overexploited.

Furthermore, while aquaculture supplies a good proportion of global fish protein needs—growing in excess of 60% between 2000 and 2008 (from 32.4 million tons to 52.5 million tons), it is not always the panacea that it is sometimes portrayed.

12.4 Trophic's in action: wheat versus meat

The trophics describe the level of an organism's place in the food chain, i.e., where it belongs in the pecking order or who eats who if you like (Johnson et al., 2014). By way of example consider the following by Miller in 1971 which suggests

> Three hundred trout are needed to support one man for a year. The trout, in turn, must consume 90,000 frogs, that must consume 27 million grasshoppers that live off of 1,000 tons of grass. ***Miller (1971)*, *pg233*.**

Other examples are numerous and often anecdotal, but all aim to highlight a particular food's role and relationship within the food chain. An alternative way of looking at this upward chain relates to the energy and food equivalents of each food type/species as we go up each level food.

The trophics are a good way of ecological accounting, taking stock if you like of what is bioavailable and what is actually being used, and in that usage just how big or small the ecological footprint.

Consider the overall food chain picture and we find there are approximately 10−50,000 edible plants species in the world, yet human kind relies to the largest extent on less than 200 of these to make up the total variety of food we eat. Concentration and mechanization also have seen even this paltry number reduced to just 15 important species on which we rely to provide up to 90% of our food. Furthermore, just three such species, rice, wheat, and corn, provide between them more than 65% of this 90%. In the animal world to the story is similar with just a couple of dozen species currently being used for food. In fact, as much as 99.9% of all animal protein comes from just nine animals: buffalo, cattle, sheep, pigs, chickens, ducks, geese, and turkeys (FAO, 1995; Joseph, 2009). Considering all this, this may not be seen as the best usage of the planets resources (Johnson et al., 2014).

The issues here are manyfold. First and foremost is the concern for the lack of variety within the average diet; this has implications in the overreliance on concentrated food sources, particularly in nutritional considerations. But more than this it has consequences within the agricultural model too—i.e., the intensification of agriculture at the expense of

biodiversity in general. Of course, this is a double-edged sword in terms of food wastage as introducing more diversity within the diet will encourage more stockholding and consequentially the potential for more waste. However, with regard to the trophic's, the issue is not really the fact that people are eating more vegetables, on the contrary this is a good thing; the concern for many is the trend for more meat within the average diet. Health issues aside, the reason is straightforward—meat is a resource hungry commodity. Rearing livestock is a very grain-intensive process and this has implications not only for the obvious food security aspect but also for issues surrounding the sustainability and management of resources (Bonhommeau et al., 2013). The main issue as mentioned is the resource intense requirements of meat production. Firstly, to put this in context, globally we annually consume about 210 million cattle, 418 million sheep or goats, 1.1 billion pigs, and 55 billion chickens[2]. That works out at about 10, 12, 15, and 13 kg of beef, lamb, pork, and poultry, respectively, or about 40 kg of meat in total for every person every year. This requires about 25%–30% of total currently available cropland and about one-third of all grain grown in the rearing of these animals, not to mention the associated environmental and energy costs too. The grain drain becomes clearer still if we convert the cost of these inputs on a per animal basis. As a simple guide, it takes approximately 3 kg of grain and 16,000 L of virtual water[3] to produce just 1 kg of meat (Nellemann, 2009). The logistics from this perspective are worrying; meat is clearly an inefficient use of resource inputs that many feel could be put to better use. And of course, the trend is for increased meat consumption, which then places further upward pressures on cereals grains. In addition to these considerations, further increases would also result in corresponding increases in water, crop, and land requirements, which might be difficult to maintain.

To further elaborate on this inefficient resource usage—we consider that nearly all life on Earth is fueled by solar radiation; that is, plants, algae, and photosynthetic bacteria convert solar energy to grow. These in turn are eaten by bacteria, insects, and animals, etc. As this takes place, the transfer of energy up the trophic levels is reduced—it diminishes. This concept refers to the ten percent rule of ecological efficiency, which is a rule of thumb that loosely suggests that energy, after consumption, metabolic processes, and energy expenditure in general, only about 10% of the original energy consumed at one trophic level is converted into stored biomass available to the next trophic level (Russell et al., 2007; Kling, 2010; Johnson et al., 2014).

Thus, from this it can be seen that by eating more meat we are effectively not utilizing valuable resources in the most efficient or optimum way; resources in fact, which could either be used to feed a greater number of people or the total production of meat can be reduced without compromising food security and/or other environmentalist issues. Of course, eating

[2]This is the based on best guestimate. Calculations are derived from FAOs food balance sheets of 2007 as well as industry standard carcass weights. Which equates to about − 63.2 million tonnes (mt) of Bovine Meat with a slaughtered per carcass weight of approx 300 kg, which adds up to 210.6 million equivalent cattle; Mutton & Goat Meat are eaten in large numbers too, to the tune of 12.6 mt with a slaughtered carcass weight of approx 30 kg which aggregates to 418.6 million equivalent sheep; Pig meat collectively equals 99 mt with a slaughtered carcass weight of approx 90 kg. This totals about 1.1 billion pigs; and lastly, Poultry Meat at 83 mt with a slaughtered carcass weight of approx 1.5 kg yields a total of 55.4 billion chicken equivalent.

[3]Virtual water is a nominal amount of water calculated to give an idea on the quantity of water required to produce a good or a service throughout the course of its growth, lifetime or production.

less meat from a finite resource pool makes sense all round, yet the question then arises; with sufficient food being grown (even after the livestock feeding) to meet global requirements, is this not then just a moot point? Of course, it would be yet to cease discussion there would be to ignore the impact of both increased future meat demands and the consequences for both the allocation of resource usage as well as the issues of the environment and energy costs too. As a result of these concerns, there are increasing campaigns aimed at reducing meat consumption in the industrialized world while attempting to slow or restrain the changing dietary patterns in developing countries (Brown, 2005; Dyer, 2006a,b).

By thinking more efficiently and more sustainably simply by changing people's diets, we could in short help support more people and help these people to live healthier lives (Bonhommeau et al., 2013). Even the World Health Organization recommends eating lower on the food chain, although in fairness this is less to do with energy efficiency or the ecological issue than it is the health aspects of eating less animal fats, etc. (WHO, 2017). Yet, for whatever reason, attempting to change dietary habits might not be as difficult as some are suggesting. By way of example just looking at a little-known paper in 1968 which looked at malnutrition and national development, Alan Berg enshrined the cultural diet in a romantic notion of immovable and transcendental importance:

> … food habits also have deep psychological roots and are associated with love, affection, warmth, self-image and social prestige. As a result, there is perhaps no aspect of personal life less flexible than one's eating pattern. ***Berg (1968)***.

Yet, while this plausible and even intuitive view might invoke a sense of truth in us, trends in the interim 40 years have shown just how fickle this notion of a traditional or cultural dietary identity has become.

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